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Reckoning Resources: Political Lives of Anticipation in Belize's Water Sector

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Abstract

Participants in Belize's water sector encounter challenges in identifying and living within shifting environments, and in conducting the work of expectation given ambiguities in rainfall patterns, historical records, institutional resources and political interests. Policymakers, scientists and practitioners generate and organise different kinds of foreknowledge as they anticipate future quantities, qualities and distribution of water, amid questions about the patterning of expertise and the nature of water as a resource. I present three ethnographic vignettes to address: the navigation of nonknowledge in water policy implementation; the frictions that arise in modelling workshops where trainees generate data-driven maps of future environments; and the situated sensing of environmental change. Building on a concept of 'reckoning' that highlights cross-cutting technical, relational, political and affective dimensions of meaning-making, I situate these foreknowledge practices in the socio-material contexts of environmental perception, economic development, and the political lives of anticipation.

Keywords: knowledge, prediction, anticipation, water, data, Belize

Introduction

This paper addresses how foreknowledge about water resources is generated, recognised and acted upon (or not) in efforts to anticipate environmental conditions and implement national policies for water resources management and climate change adaptation in a coastal country in central America. For those involved in operational decision-making and longer-term strategic planning in Belize, current negotiations of knowledge and policy around future water resources are shaped by histories of organisational development, location and responsibility. For example, the sites of weather stations and status of data archives are influenced by colonial legacies; also important are the technological capacities of meteorological and hydrological services, current political priorities, and the roles of international networks, donors and experts. I build on theoretical work in STS and anthropology to analyse the technical, relational, political and affective dimensions of quotidian knowledge practices of scientists and practitioners in public, private and NGO sectors as they craft credible futures, and encounter questions about the limits of science and the patterning of expertise and authority.

The scales and horizons of knowledge production and decision-making about environmental futures extend spatially across pixels, grid squares, communities, organisations, districts, river basins, coastlines, nations and regions, and temporally from 'real-time' to multi-decadal frames. While global infrastructures are at the heart of endeavours to model the atmosphere (Edwards, 2010), the effects of atmospheric changes are experienced as the medium of everyday life. Ingold (1993) contrasts a characterisation of the environment as a globe, separated from the observer and apprehended in a detached way (as abstracted in the techno-scientific visualisation of a general circulation model), with a perception of the environment as a sphere, known from within, for example as weather conditions experienced phenomenologically (Ingold, 2010). Other scholars have sought to complicate the duality of such models, arguing that while the 'global' pretends to a view from nowhere, or everywhere (Haraway, 1988; Hulme, 2010), it is itself constructed and stabilised through contested political-economic, infrastructural and sociocultural efforts that are locally embedded (Blok, 2010). Knowledge infrastructures can adopt different models of participation that afford different scope for empowerment and marginalisation (Jalbert, 2016). Scientists are also citizens and the boundaries between 'the lab' and 'the world' are not clear-cut (Monteiro and Rajão, 2017); we come to know the atmosphere through diverse senses, measurements, practices and comparisons (Choy, 2012).

A growing literature in STS and related disciplines has explored these imbrications of perspective and identity in the production of predictions and future imaginaries: how states mobilise anticipatory knowledge to support policy directions (Nelson et al., 2008); and how discourses of risk management and other ways of rendering the future present and actionable are interlaced with culture, society and politics (Anderson, 2010; Beck, 1992; Demeritt, 2006; Douglas, 1992; Hulme, 2009; Rayner, 2007). Ethnographic studies of environmental forecasting have addressed how meteorologists and climate scientists position themselves and their models and forecasts (and how they are positioned by others) with respect to uncertainty (Daipha, 2015; Fine, 2007; Lahsen, 2005; Shackley, 2001; Taddei, 2012); and elucidated the social lives and 'performativity' of foreknowledge, and the challenges of accountability and equity for decisions about resource allocation (Barnes, 2016; Broad et al., 2002; Hastrup and Skrydstrup, 2013; Taddei, 2013). In line with the aims of this special issue, I seek to engage the political dynamics of producing and negotiating foreknowledge; I do this by focusing on processes of 'reckoning' future quantity, quality and distribution of water to illuminate the sociality and materiality of anticipation in a context where climate change and water management are explicit policy challenges.

The paper proceeds by presenting the research setting and methodology. I then introduce 'reckoning' as a lens for exploring knowledge production and negotiation under uncertainty, before applying it to three empirical vignettes. In the first, I address the shifting political grounds on which institutional decision-makers are *reckoning with(out) data,* and how knowledge and nonknowledge for policy are organised and critiqued. I then examine experimental practices of hydrological modelling — ways of *reckoning with models* — involving the friction of negotiating standards, expectations and meanings across observed, imagined and simulated worlds. The third vignette considers *affective reckoning,* foregrounding how people orient themselves given shifting points of reference that can trouble ideals of integration, translation and management. These modes of reckoning — involving formal calculation but also opinion and judgment — are not necessarily mutually exclusive. They can however demonstrate different emphases with respect to the resources they value and put to work to anticipate future water, given incomplete knowledge of future weather and climate, limited/unevenly distributed material resources, and pressure to make timely decisions. I discuss how 'reckoning resources' can thus be understood in multiple ways: as the challenge of confronting uncertain resource futures; as the practice of calculating or estimating future water; and as the tools (including data, models, senses and expectations) that are put to work in anticipatory practice. I conclude that paying attention to modes of reckoning environmental futures, and to their cross-cutting technical, relational, political and affective dimensions, is a way to foreground the socio-material conditions under which foreknowledge may be made meaningful across contexts.

Research setting and methodology

Belize is recognised to be particularly vulnerable to impacts of climate change and variability at various timescales, with potential implications for crucial economic sectors of tourism, agriculture and fisheries (CaribSave, 2012; Richardson, 2009). Many of these anticipated impacts directly or indirectly involve changes in quantity, quality and/or distribution of water, for example sea-level rise, saline incursion, and variations in patterns of rainfall, evaporation, flooding, and coastal erosion. Although it is located mostly on the Central American mainland, the country is recognised within the UN system as one of the 'Small Island Developing States' (SIDS) that share climate change vulnerabilities, among other characteristics. With reference to Hau'ofa's (1993) vision of a 'sea of islands', Lazrus (2012) has explored how island states and communities facing climate change are not as isolated as conventionally assumed: Belize is no exception, in light of not only the transboundary watersheds it shares with Mexico and Guatemala, but also its social and infrastructural connections across and beyond the Americas and Caribbean. Belize is thus a productive site for exploring different ways of knowing and potentially acting on future water across times, spaces and institutions.

The empirical research underpinning this article was undertaken in Belize over three months in 2014, as part of a wider interdisciplinary project examining the usability of weather and climate forecasts for resource and hazard management in different national contexts and sectors. The study was designed to investigate social/institutional dimensions of forecast use and non-use, by paying attention to how (potential) forecast users situated themselves in organisations and decision processes; how they gauged success; how they did (or did not) access and use weather and climate information; and how they prepared (or did not) for future conditions. The study also sought to examine forecasters' definitions of success, and their relationships with their technical tools and with other decision-makers. To these ends, ethnographic observations and semi-structured interviews provided insights into forecasters' and users' lived experience; their views of their roles, opportunities and constraints; and the meanings they attached to their decisions and interactions. Throughout the research and analysis, relating insights from these two methods to each other and to materials including mission statements, forecast products and policy documents enabled validity checking and identification of patterns and differences in practices, perspectives and priorities.

In Belize, where I have conducted anthropological research since 2006, the ethnographic study included (participant) observation of forecasting centres, training sessions and planning activities in the water sector, including three operational shifts at the National Meteorological Service, a two-day hydrological modelling workshop, and a coastal planning seminar. This afforded practical insights into participants' applied and embodied knowledge, and opportunities for learning as situations unfolded. I also conducted interviews with 60 water sector participants, including environmental and climate scientists, weather forecasters, utility suppliers and regulators, and government/NGO staff in agriculture, natural resources, and emergency management.[1] The interviews were based on a shared but flexible protocol to enable in-depth discussion of issues important to participants, coverage of topics that may have been elusive during only three months' of ethnographic research, and opportunities for pursuing and validating emerging themes from observations and other interviews. They also offered efficient use of time when interviewing busy professionals (Bernard, 2011: 157-158). I typed daily fieldnotes, and recorded/transcribed interviews for qualitative interpretive analysis. Working with these methods helped clarify how future water quantities, qualities, and distributions are reckoned — and reckoned *with* — in Belize.

Limitations of the methods include the relatively short duration of the ethnography, which precluded following how forecasting or training endeavours developed over seasons and years. The focus on people who were willing to participate in interviews and observed events introduces potential for self-selection by those with a particular orientation to forecast production and use. I was attentive to this, particularly as Belize's low population means that there are a limited number of actors involved with relevant work; I developed a network of key informants to help me connect with participants who may have been less visible or engaged. This study was designed primarily to address forecast production/use in professional contexts; as such, it did not thoroughly examine the roles and perceptions of wider 'publics' also affected by the information and decisions in question. When interviewing people in their professional capacity, their responses may reflect official lines rather than personal perspectives. Both are interesting: the flexibility and rapport afforded by the semi-structured format, and the insights from ethnographic encounters and observations (sometimes involving the same interviewees) helped build a picture of what people do as well as what they report.

Reckoning (with) resources

In this paper, I use the notion of 'reckoning' to explore how scientists, public servants and other practitioners in Belize's water sector navigate shifting atmospheres, temporalities, values and commitments as they look to the future of water resources and hazards. I find the term's multivalence useful for thinking through different approaches to measuring and framing (im)precision or (un)certainty: reckoning formally means to count up or calculate; it also refers to estimation, expectation, trust, opinion or judgment. Along with these more or less direct paths to knowledge, its allusions to settling (accounts), tackling (challenges) and envisioning (possibilities) span temporalities and are suggestive of the resources, reputations and livelihoods that are at stake as practices of water assessment and prediction move between objectivity and interpretation, closure and ambiguity.[2] These processes of abduction — of "tacking back and forth between futures, pasts and presents… turning the ever-moving horizon of the future into that which determines the present" (Adams et al., 2009: 251)[3] — have affective power (see also Zaloom, 2009) and can influence action in the face of uncertainty, imprecision and/or ignorance.

Anthropologists Kockelman and Bernstein (2012) discuss reckoning time as a particular approach to framing temporality (distinct from metricality, performativity, or worldview) that "foregrounds the when and how long of an event [and] focuses on the social, semiotic and material resources we have for telling the time" (Kockelman and Bernstein, 2012: 324). It involves triangulation: using privileged periods of repetition and points of orientation to size and order the *event to be reckoned* relative to the *event of reckoning* (Kockelman and Bernstein, 2012: 326). Kockelman and Bernstein's (2012: 336) analysis highlights technical, relational and political dimensions of reckoning, and thus counteracts what they describe as a "pervasive theoretical insistence on independent, abstract, empty, homogeneity [that] obscures the dependent, concrete, full, heterogeneity of our actual everyday situated modes of temporal being" . This argument frames their discussion of 'portability' — the extent to which meanings produced through different semiotic technologies (such as language, clocks and calendars) can be understood and applied across historical and cultural contexts — as something that varies according to the simplicity of the technology, the knowledge shared by speaker and addressee, the relative sizes of the populations that control and reckon with privileged points, and hierarchies of credible measurements. Portability, they argue, relies not on absence of context, but on relations and mutual knowledge. The notion resonates with analyses by historians and scholars of science and technology who explore the production and circulation of immutable mobiles (Latour, 1987: 227), boundary objects (Star and Griesemer, 1989) and different modes and conditions of objectivity (Daston and Galison, 2007; Porter, 1995).

Reckoning can be applied to domains other than time.[4] While I do not apply their thorough linguistic analysis, I draw on Kockelman and Bernstein's (2012) understanding of reckoning as a useful point of entry to consider how attempts to make measurement meaningful and establish shared understandings about future water are at once technical, relational and political. This foregrounds how diverse resources are mobilised by scientists and practitioners to know about quantity, quality and distribution of water. The problem of anticipating its *future* characteristics adds further challenges. I situate these lines of enquiry in conceptual frameworks that see the implications for those reliant on the resources in question as bound up with an epistemic environmental politics whereby power dynamics among different ways of knowing can make particular futures more or less salient or imaginable (Groves, 2017; Jasanoff, 2004; Taddei, 2013), and that call attention to the role of material forces in influencing knowledge-seeking and world-making (Vaughn, 2017). Who has authority to determine legitimate units and points of reference? What instruments and processes are used to assess current and future resources? What are the implications for people whose lives are bound up with the environments in question? I see these three provocations mapping respectively onto three sites that Orlove and Caton (2010) propose for anthropological analysis of water: *water regimes* (institutions, rules and tools of water governance); *watersheds* (hydrogeographical units of assessment and intervention); and *waterscapes* (experiential entanglements of place, ideology and meaning). These respectively underpin the following three empirical vignettes, which discuss shifting governance, modelling practice, and sensory experience of reckoning resources in Belize.

Reckoning with(out) data

While environmental variability is not new to Belize, some anticipated changes are now being framed as existential threats, for example in regional assessment and policy documents that highlight rising sea levels, coastal erosion, saline intrusion, escalation in intensity of extreme weather events, and disruptions in rainfall and fresh water supplies (CCCCC and CDKN, 2012). Official classifications and measurements of baselines and extremes make — and remake — environmental resources and hazards through scientific practice and policy decisions that authorise particular technologies, motivations and objects of concern (Bond, 2013). In this section I examine how scientists and policy staff discussed data in relation to a shifting *water regime* (Orlove and Caton, 2010), paying attention to the power dynamics of knowledge and nonknowledge.

Water in Belize is vital for drinking and sanitation, for agriculture, tourism, cultural practices, place-making, fisheries, coastal development, hydropower, and conservation. It is thus a matter of concern for local and national governments, nationalised and private companies, NGOs, consultants, universities and research institutes, communities, indigenous groups, and individuals. Relevant responsibilities and knowledge are distributed among many different entities. For example, municipal supply, sewerage and some rural supply is undertaken by Belize Water Services Limited, with other rural supply managed by village boards under government oversight. Drainage infrastructure is largely the responsibility of municipalities. National electricity distributors and private dam operators manage water for hydropower production. The National Emergency Management Organisation (NEMO) oversees flood events and other emergencies. Surface water data is collected and collated by the government Hydrology Unit; the Met Service records and forecasts precipitation, and undertakes climate science-policy related duties (e.g. representing the country in UNFCCC processes) alongside the nascent National Climate Change Office, in collaboration with regional and global bodies including the Caribbean Community Climate Change Centre (CCCCC), the Caribbean Institute of Meteorology and Hydrology, and the World Meteorological Organisation (WMO).

Shifting regimes

There has to date been little control of the abstraction and use of water in Belize. The National Integrated Water Resources Management policy, presented by government in 2008, promoted a vision that formally vested water resources in the state and gathered responsibilities for water resources management under a national commission. The rationale for instituting Integrated Water Resources Management (IWRM) in Belize was that past water policies had been too "parochial" and there was minimal understanding of climate change impacts (BEST, 2008). The policy was followed in 2009 by a National Adaptation Strategy for the water sector. Citing the IPCC, the strategy's technical review identified trends in temperatures, precipitation regimes and extreme weather as motivations for improving water governance to benefit present and future generations,[5] and noted that the lack of a comprehensive water monitoring programme in Belize precluded quantification of threats to water (BEST 2009). In 2011 the government enacted a National Integrated Water Resources Act. At the time of research, however, responsibilities remained fragmented, with water regulated for example as industry by the Public Utilities Commission, as effluent by the Department of Environment, as drinking water by the Ministry of Health; regulation of water as 'raw' natural resource was expected to be the domain of the prospective National Integrated Water Resources Authority (NIWRA). The development of NIWRA (a process dating back to at least to the 2003 reactivation of a Pro Tempore Water Commission that was revived and formalised in the 2011 Act) was a significant dimension of shifts in the water regime underway during the research period (FAO, 2015).

IWRM is an internationally instituted approach that, according to the Global Water Partnership, "promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP, 2000). The watershed is deemed the fundamental unit of analysis and intervention, with emphasis on scientific management and the development of an international network of experts and donors (Caton, 2007). As part of efforts to institutionalise IWRM in Belize, the Hydrology Unit had been moved in 2012 from the Met Service headquarters near Belize City, to the then-Ministry of Natural Resources and Agriculture in Belmopan, where it was destined to act as the NIWRA secretariat.[6] At the time of research, the project to develop NIWRA as an autonomous body to promote stable and independent oversight for water issues was progressing under climate change funding from the European Union. A major NIWRA objective was to create datasets to reduce uncertainty about current and future water resources, and ultimately produce a national 'masterplan' based on assessments of water availability and stakeholder demand, which could be used as a management tool to inform licensing and fees.

Throughout my research, Belizean scientists and policy officials frequently framed the problem of water management in terms of insufficient data. In doing so they emphasised potentially reducible epistemic uncertainty, suggesting that water is a theoretically calculable — and thus governable — resource (Scott, 1998): a view that seems well-aligned with IWRM's science-led approach. A participant involved with NIWRA development was not the only interviewee to lament: "we can't manage what we don't know." I heard complaints that data were lacking in quantity — over time (historical records do not go very far back and there are gaps in the records) and space (there are few gauging stations, issues with accessibility for reading/maintenance, and a lack of groundwater monitoring) — and also in terms of quality, related to challenges of maintaining and calibrating instruments and relying on volunteer observers.[7] Discussing themes of evidence-based decision-making, a water expert at the utilities regulator expressed frustration about being caught between the potential costs and benefits of a precautionary approach, implying the need for more data to help overcome this impasse:

> If you don't know the amount of resource that is there, you cannot manage it properly. You probably might be over cautious, and so you're not getting what you want. Or you might be negligent and aggressive and causing it to go at-risk.

The implication here is that having more data will allow measurement and quantification of the available present resource (at the point of reckoning), which in turn would facilitate reckoning of future amounts (given an understanding of likely trajectory), and hence the ability to influence these future amounts via management of abstraction and use. The situation of not-knowing current quantities was presented as disorientating: a sense that without a stable baseline at the point of reckoning, the enterprise would be futile.

Taming nonknowledge

In conversations with government policy staff, I asked how they go about their work in this situation. The following quotation demonstrates ambivalence: the official opens with confidence in existing knowledge, before noting that there are 'known unknowns' that trouble the ability to project with precision:

> We are aware of what our aquifers are. We know where they are… there are regional maps with the transboundary aquifers, and so we know what the source is... With satellites, there are calculations that you can do that make the projections. But the calculations are based on unknowns, and it's better when they're based on knowns... So, it's really a case of we calculate based on what we know, but we know that we don't know the extent.

The official gestured across a desk piled high with papers, and explained that they use frequent reporting, data mining and iterative decision-making to face these limitations:

> We project, we document, we adjust; we project, we document, we adjust. And we go through that iterative process. And so, we're tending towards infinity. We are getting closer and closer to be able to effectively say, "OK. Well, based on our experience this is going to be equal to that."

With its heavy documentation and auditing — in the official's words, "a lot of statistics" — the process is presented as a dynamic form of reckoning that applies different technologies of observation, calculation and comparison using satellites, maps and statistics: an effort at triangulation using the situation at the 'speech act' of the projection (based on available 'current' data from e.g. gauges and satellites), and the calculations of expected change to project a future picture of water quality, quantity and distribution. This is subsequently 'ground-truthed' against observations and adjusted so that it tends towards an imagined end point where expectation meets eventuality and the problem is tamed. The government had recruited consultants to conduct a hydrological assessment of the southern portion of the country, which was intended to provide the background information that would enable projection into the future, taking into account population expansion and climate change. In these early stages of IWRM implementation, a key government goal was to develop a licensing regime (focusing on industrial abstraction), thereby instilling the IWRM principle of water as an economic good. Interviewees explained that, given the data shortage, the government was allowing a 'grace period' whereby licenses were being administered but not yet charged as part of the environmental impact assessment process, with the condition that licensees install flow meters and submit this data along with their abstraction rates to the ministry. Ministry staff would check the actuals and may change the conditions of the annual license accordingly. This can be read as a performative exercise: piloting the programme as a means to procure baseline data, which will then facilitate checking, adjustment and — ideally — scientific management. At stake is the conceptualisation of water as a calculable and governable economic good.

Political data ecologies

The scientists I encountered frequently framed the data problem as a problem of distribution (and thus politics). Their descriptions of the knowledge ecologies of sharing, concealing, overlooking or denying data and contextual information support an analysis of nonknowledge or ignorance as not a simple opposite of knowledge or lack of competence, but something that can be actively constructed, strategically managed, contested or mobilised to allow certain forms of work or life to continue (Anand, 2015; Dilley, 2010; McGoey, 2012; Power, 2007; Rayner, 2012). As Mathews (2014: 82) notes in his study of Mexican forestry, nonknowledge can be "tamed as calculable uncertainty, or alternatively transformed into ontological indeterminacy, scandals, and stories of corruption". Indeed, while policy workers — focused on turning available data into management — described processes of reckoning-as-taming, many scientists used discussions of the challenge of reckoning without sufficient data as avenues for political critique. While most stated a commitment to the theoretical calculability of water resources — and the principle of science as a "less contestable" mode of decision-making — institutional/political factors made them doubt that improved data availability and analysis would be practically possible and, even if they were, whether they would lead to real change.

Current and former public servants and scientists spoke of institutional barriers to cumulative, consistent and contextualised bodies of knowledge over both time and space. In terms of time, they alluded to losses of institutional memory when units and programmes were moved in civil service reorganisations, or when leaders were replaced according to electoral cycles. The short duration and external control of many projects impedes continuity; important documents may be removed overseas or otherwise rendered unavailable for future reference. With a shortage of trained experts employed by government departments, the small pool of available consultants relied on for much research and policy drafting raised questions for some about accountability, conflicts of interest, institutional memory and duplication of efforts. For respondents raising such objections, the problem was not so much that datasets had not been produced, but that they could be disregarded by leaders seeking to make their mark with new projects.

The spatial dimension was reflected in complaints about the reluctance or inability of organisations and individuals to share data, both within Belize and across national borders: the latter was of concern given that more than half of Belize's population rely for their potable supply on water that originates in neighbouring countries (BEST, 2009: 9). A framework was in place for cooperation with Mexico, but diplomatic relations between Guatemala and Belize remain sensitive and formal data sharing agreements were lacking. Belizean scientists and technical staff reported exchanging information through informal networks and meetings with counterparts at international conferences. A commonly cited example of data-sharing obstacles within the country was the physical and institutional removal of the Hydrology Unit from the Met Service. Several respondents expressed frustration that this had distanced the Unit from cognate work, making data sharing difficult, and flood forecasting effectively impossible. These issues were compounded by the situation that at the time of research there was no hydrologist in the Hydrology Unit — a case frequently deployed as an archetype in commentaries about the problems of managing public sector expertise and human resources, and government apathy to environmental science. Scientists and regulators raised the challenge of overcoming a "mindset" or "culture" in Belize that views data as property and political capital. In the words of a former government scientist: "Here in Belize, people tend to hold on to information as if it's gold."

Scientists and practitioners attributed political apathy about future resource pressures to a false sense of security related to Belize being a country with abundant water and low population density, but also to incentives for politicians to maintain discretion over resource allocation and keep debates about distribution out of the public sphere, particularly given connections between water and land, which is of fundamental importance in Belizean politics (Haines, 2012, 2018; Grandia, 2009; Wainwright, 2008; Wilk, 1997). Thus, there was doubt that even with data collected, made available and translated into policy, there would still be the problem of enforcement — again, frequently described as typical of Belize, or the Caribbean (see also Medeiros et al., 2011). This was seen as not only a symptom of scarce governance resources but a strategic performance of legitimacy for donors, stopping short of practical change. As an environmental scientist explained:

> We end up with these beautiful plans… That's what [funders] want to see -- policies change; they want to see legal frameworks change. But those are no good if there is no enforcement and if they are not implemented… Our policies are beautiful, actually... They say nice things. We've got to close that loop — from policy to legislation to enforcement …

In the current context, the scientist thought that taming the issue through specific and quantified economic arguments might have some influence, but in the longer term the situation would be unlikely to change without a shift in political culture from factional clientelism to more transparent democracy.

These critiques move focus from nonknowledge as calculable uncertainty towards narratives of the control of information by institutions for which such knowledge would be uncomfortable or inconvenient (Mathews, 2014; McGoey, 2012; Rayner, 2012). While conflicts about data availability and sharing are of course not restricted to this location, the common identification — by Belizeans — of such an attitude as a national phenomenon corresponds with a broader vernacular critique of political elites and their strategic relationships with (non)knowledge. It connects with melancholy expressions of nationalism, for example in newspaper editorials that speak of a sense of inferiority, rooted in colonial subjugation and maintained through reliance on external projects, and the notion of untapped potential, restricted by resource shortages and 'bad politics'. It was clear from my interviews and ethnographic encounters that many scientists experienced these frustrations as an affecting and emotional context for their work.

In this section I have discussed how a changing water regime provides the grounds for reckoning with(out) data. Resonant with the 'normal science' rationale of IWRM (Orlove and Caton, 2010: 410) and its conceptualisation of water as an economic good, water policy officials and scientists articulated an urge to quantify: mobilising an idea of certainty as theoretically attainable (Hulme, 2009: 84) and water resources as potentially knowable and manageable, if only political contingencies could be contained. For the policy staff, reckoning with different sources of data and uncertainty was presented as an iterative process working towards an eventual imagined alignment, whereby resources could be scientifically managed through a licensing system based on correctly anticipating supply and demand. The uncertainties of the current situation created the conditions for this new policy work to be done. Writing about municipal water supply in Mumbai, Anand (2015) notes that the material resistance of water and its associated infrastructures to calculation and governance is influential: it affords spaces for contestation and strategic ignorance that enable water engineers to carry out their practical work. Ballestero (2012) has examined the productive roles of faith, dissent and ruptured numeric logics that generate relations and potential in water policy processes in Brazil and Costa Rica. In Belize, too, material and social things confound certainty about water. This generates debate about not only how policy should be made and implemented but also how politics should be done. Thus, reckoning with(out) data also means reckoning with environmental and political indeterminacies.

Reckoning with models

In this vignette, I turn from the policy sphere to a training workshop concerned with reckoning future water by wrangling software and data to run models that would visualise runoff and erosion in decades to come. This hydrological modelling practice was underpinned by the topographically defined concept of the *watershed*, and the temporal scale of climate projections to 2080. The event was one component of a research project assessing the potential impacts of climate change on Belize's water resources. While, in the wider project, modelling specialists were using similar processes to produce new datasets and technical reports, this workshop was envisioned as a training opportunity for people working in different sectors: to learn about available tools; to explore 'what would happen' to water resources under different climate change and land use scenarios; and to consider the impacts for their professional domains. The international financial, technological and knowledge infrastructures behind the endeavour were made clear through the collaboration of the national university with regional NGOs and scientific institutions, funding from international agencies, the use of IPCC scenarios to frame the modelling exercise, and the venue: a Taiwan-funded computer lab in the Belizean capital city. Many of the 20 or so participants wore shirts embroidered with the logos of government ministries (e.g. agriculture and natural resources; forests, fisheries and sustainable development); others hailed from NGOs, consultancies and universities. Some had brought laptops already loaded with the ArcGIS mapping software that most participants used in their work; the rest of us logged into the lab's PCs and loaded a free alternative programme.

Over two days, the course facilitators introduced online sources of global climatological data, satellite observations, and future rainfall scenarios. On our screens, the maps — based on watersheds — projected a unit of analysis that exceeded the familiar national map of Belize, extending into Guatemala and Mexico, and drawing attention to incongruities between physical and political boundaries. The climate datasets we downloaded from *worldclim.com* comprised monthly averages for past, current and future temperature, precipitation and bioclimatic variables at resolutions of up to 1km^2, with observations interpolated for areas lacking weather stations, such as the expanse of the Maya Mountains. The future datasets had been derived by downscaling 19 general circulation models in the CMIP5 (fifth Coupled Model Intercomparison Project), run according to IPCC scenarios. Using the GIS software and the N-SPECT (nonpoint-source pollution and erosion comparison tool) extension, downloaded from the US NOAA (National Oceanic and Atmospheric Administration) website, we followed instructions to apply future precipitation and land use (i.e. deforestation) scenarios to maps of soil type and elevation. An early task was to activate the digital elevation model (DEM), which underpins the representation of the watershed as the key to water behaviour: water flows downhill, so the elevation of each grid cell relative to its neighbours determines the direction of flow. Using these resources, we would be reckoning future quantities, qualities and distributions of water. Scientific calculations would transform the baseline observations into projections using complex mathematical relationships among factors including soil type/moisture, rainfall amount/intensity, and topography; allowing us to query how variables could shift under different climate and land use scenarios.

While many of the workshop participants were familiar with using GIS software to map existing circumstances, few said they had used the demonstrated techniques to cast GIS maps into the future (or cast the future in maps). In response to prompts about how the techniques from the workshop could be transformed into practices with operational relevance, practitioners spoke of different sensitivities, information needs, technical constraints, responsibilities and capacities for enacting decisions relating to future water quality and quantity. Nonetheless, the extent of the promise of GIS felt among its proponents was characterised when, during a coffee break, one participant remarked that a lot of GIS work in Belize had started "for [biodiversity] conservation", but was now "for society".

The work of friction

Slowed by internet connection delays that disrupted smooth data downloads, we nonetheless conjured flickering visualisations of what might happen to water accumulation, runoff, and sedimentation over the next 35 years. The models ran slowly, causing some impatience. We were occasionally derailed by inconsistencies between the free and licensed software, prompting joking interjections about pirated versions, aimed at representatives from the software distributor who were present. For example, one software version automatically performed a correction to fill in 'sinks' in the DEMs that can cause problems for the next modelling stage; in the other version this had to be done manually. The question was posed: how would one know if the sink correction had been done or not? The response was to look at the model output map and check it against prior knowledge about the location of major accumulation points (e.g., river mouths).

These kinds of challenges illustrate what Edwards (2010: 83-86) terms the data and computational 'friction' of working with large data sets, multiple computer systems and diverse organisations to create and manipulate global atmospheric simulations. In his definition, computational friction is the resistance that hinders the conversion of inputs into information and knowledge; data friction is the (energy, attention, time) cost of moving data among machines, humans and organisations. In the workshop, these frictions made themselves known through the slow-moving progress bars that sent us seeking coffee ('run time is uncertain…'), in the different maps displayed on my and my neighbour's screens after attempting to perform the same operations on the same datasets, and in the frustrations of the workshop convenors who had spent time checking the data and instructions only to be faced with unexpected outcomes. Dealing with such frictions involved social and physical energies: switching file formats, converting inches to centimetres, re-running models, making jokes, offering reassurances about the validity of the methods, and advising trainees to confirm model outputs with reference to prior knowledge.

Further frictions became apparent in the course of participants' questions to the modelling experts leading the workshop, as they raised queries about data provenance, model assumptions, physical processes, and judgment of what the models were expected to reveal and what they might be useful for. There was animated discussion about the terminology and scale of watersheds, catchments, sub-catchments, and of *cuenca*, *subcuenca* and *microcuenca* in Spanish-speaking neighbouring countries. Watersheds are seen to be useful management units, but these conversations made it clear that their definition is not always a given. As we were guided through the model setup in the N-SPECT plugin, questions arose about the default inputs. The curve numbers (used to predict runoff resulting from rainfall events in particular areas) had been developed in the USA: it was suggested that a future research agenda could include developing more locally relevant parameters. Government water and environment specialists noted that many of the pre-defined water quality standards were based on those of the US Environmental Protection Agency, while best practice in Belize was guided by World Health Organisation standards. Other pollutant threshold values that had been derived from US studies (according to the user guide) were treated with some suspicion by the government environment officers who explained "the way we do things here". The facilitator emphasised the possibility of adjusting the defaults to locally relevant values in future uses of the model. (We eventually moved on, disregarding the output analyses that used the figures that the government officers professed not to trust.) There were also questions about the input of numbers of thunderstorms and intensity of rainfall, as recorded in my fieldnotes:

> We also have to add a figure in a box marked 'raining' — this stands for the number of raining days per year, defined as the average number of storms in one year in the period of interest. In Panama [where project contributors have been developing the models], they always used the number 40.[8] Some participants picked up on the Biblical reference… This number was subject to quite a lot of debate. Is 40 a good figure? How might this change? What does reducing/increasing it do?

These debates were about the degree to which people and organisations shared knowledge of — and were convinced about — the units of analysis and points of reference being used to reckon qualities and quantities of future water. As such, they concerned the portability of the modes and outputs of the reckoning process (Kockelman and Bernstein, 2012): the extent to which the validity and meaning of the parameters and modelling process could travel across geographical locations, environmental contexts, and regulatory landscapes. Dealing with the friction of standards and inputs, datasets and software took time and social work, including that which had gone in to designing and justifying parameters and software to account for (some) differences (as evidenced in the tools and user guides), and also the facilitators' efforts at clarification. These translations sometimes succeeded and sometimes did not succeed in convincing workshop participants about applicability across cultural and environmental contexts; they generated lively discussions about model assumptions, limitations and potential.

Modelling interdependence

To correct for model processes that made water seem to pool 'unrealistically' in output maps, we were instructed to perform a function that 'burned' digitally into the underpinning topographical layers. The facilitator's explanatory simile — that this was "like digging a ditch in your land to make the water flow where it should flow" — collapsed the divide between the model and the physical world, bringing earthy realism and physical labour to bear on the pixelated layers before our eyes, inviting us to craft a more realistic version of the model by figuratively carving into its representational landscape: the DEM. As for the sink-filling operation mentioned above, the implication was that knowledge of the material world had to be mobilised to check and correct the visuals being called forth on our screens.

The model of nature built in the software's equations seemed to have what Munk (2013), in an account of his own flood modelling apprenticeship, calls "its own anticipations": "it exacts a certain demeanour on behalf of its modellers; it expects us to feed it with a world rendered in specific and digestible formats" (Munk, 2013: 145) — for example the input parameters mentioned above. Munk (2013) argues that the interdependence of the model and modeller in scenario generation both requires and produces a hybrid through which uncertainty and surprise may proliferate, thus 'emancipating' nature from bounded assumptions, not merely working as a tool to anticipate a nature already 'out there'. This resonates with an 'abductive' mode of anticipatory reckoning, open to surprise and undetermined outcomes, and operating through a 'workmanship of risk' (Hallam and Ingold, 2007; Pye, 1968) which bears the possibility of failure. Adams et al. (2009: 255) describe computer modelling as a "standard means of abduction", and abduction as a core dimension of anticipation which focuses attention on how the present can and should be influenced by particular futures. Responding to challenges about the input values, and making the case for the usefulness of the approach in a range of management contexts, the instructor emphasised that a key benefit of the N-SPECT tool was the capacity to 'tweak' settings and inputs to experiment with different possibilities and decisions, for example to separate different kinds of land use and rainfall trajectories to make different relationships and possibilities visible. The training thus highlighted the constrained manipulability of the model as a "mutable mobile" (Morgan, 2012: 398) — a tool for reasoning and imagination, in which the barriers and frictions that trouble the portability of technologies and meanings (Kockleman and Bernstein, 2012) can at the same time open debate about environmental and political uncertainties.

Reckoning with models is thus a relational anticipatory practice: it relies not only on hydrodynamic equations, interpolation techniques, and infrastructural data connections, but on experiences, regulatory contexts, and discursive explanations relating virtual to physical, watershed to polity, baseline to scenario, and model output to human expectations. Highlighted through its status as a training session, the modelling practice during this workshop was less about calculating specific outputs than about experimentation: visualising multiple alternative futures; asking participants to consider potential uses of the tools; and situating us in relational interdependence with the model. Through this, our ability to affect the mapped outcomes — in intended and unintended ways — served as an analogy for the sensitivity of water to climate and land use change; demonstrated the fragility of the model itself; and invited us to adjust its parameters to more closely match our perceptions, knowledge and expectations of the material world. The experimental framework and its associated frustrations revealed the work of making translations that (partially) stabilise the models to the extent that they can act as a shared resource for meaningful negotiation. While the process evoked by the policy worker in the previous section was one of narrowing towards an ideal alignment of expectation and eventuality, mediated by iterative interventions and feedback, the workshop conjured a proliferation of futures that caused participants to question what kinds of interventions might have different effects.

Affective reckoning

In this final empirical vignette, I address facets of reckoning future water that connect foreknowledge practices to the material and meaningful affordances of the *waterscapes* that people inhabit. If (as Kockelman and Bernstein (2012: 326) set out for spatial and temporal reckoning using maps and calendars) a requirement for triangulation is being able to relate one's own position to a privileged point of reference/point to be reckoned, it is relevant to ask: how do people working with water policies and models position themselves within the environment as they reckon present and future water? The preceding vignettes have touched on some ways of identifying circumstances at the point of reckoning (for example through baselines/current datasets); I now focus on examples of how phenomenological and narrative knowledges are negotiated in (dis)connection with scientific understandings.

Strange weather

One theme that emerged strongly during my fieldwork was how people reckoned time and climate in seasonal terms, and the conundrum of doing this when expectations did not match experience. What does it *mean* to say we are in the wet season? When is a wet season not a wet season? Forecasters, agriculturalists and dam operators pondered aloud the "strange" weather conditions throughout my research starting in August 2014. At that point, we were either experiencing an exceptionally dry wet season, or a prolonged dry season. The dissonance between expectation and experience was interpreted and articulated in different ways. For most respondents, including the meteorologists from whom I sought professional opinions, definitions of wet and dry seasons were aligned with certain months, based on historical trends. In this understanding, the rainy season (usually preceded by a short rainy spell and brief pause) is typically defined as coincident with the hurricane season (June-November): as such the season is not defined based on a trigger or threshold in observed conditions. It is thus possible that material conditions do not fit the seasonal description (as in the observation of a "dry wet season").[9] An alternative perspective was articulated by the sugar industry workers who told me, in a dusty Orange Walk town in September, that the rainy season "would soon come", and by an agriculture officer who noted that one year, when it started raining in October and continued for several months, there was "almost no dry season." These alternative modes of orientation situate the speaker within material conditions rather than calendar-based seasons, and highlight narrative tensions between the two.

These different attempts to account for dissonance between expectation and experience communicate the widespread notion that atmospheric conditions had recently become unpinned from established points of reference. They draw attention to the relational work of reckoning water in the present, let alone the future: both in terms of the challenge of communicating meaning when expectations based on shared seasonal calendars are destabilised (as in apparently oxymoronic descriptions of 'dry wet seasons'); and the translations that are possible based on shared cultural understandings of what different seasons have meant in the past, and of (sensed and/or narrated) slippage. These tensions, sensations, opportunities and emotions, mobilised in discourses about weather and climate change, are part of the context in which scientists and policymakers operate. Rather than always existing at a remove from technically-mediated measurements and trends, the sensory dimensions of weather and water knowledge are often implicated in scientists' narratives and justifications. For example, a facilitator of the modelling workshop referred to the colour of the Belize River as viewed from his plane window on landing as an indicator of the anomalous current season. This observation inspired a workshop exercise using satellite data to compare this year's rainfall readings to an ostensibly 'normal' historical year, thus bringing different knowledge sources into conversation.

It is not my intention here to discuss evidence of shifting patterns, but to reflect on the ways in which people framed their interpretations of weather as experience and climate change/variability as a domain of knowledge extending into more or less distant pasts and futures.[10] Perceived shifts were attributed to different physical factors including El Niño, longer-term climate change, and land use practices. For example, a member of technical staff at the Agriculture Department mixed personal and professional experiences as he noted that, while not everyone is familiar with 'climate change' as a concept, changes are registered through situated awareness, memory and comparison:

> I remember growing [up], my grandfather saying the first of May he will plant because he knows rain is coming. [It] worked, yeah… Maybe a farmer might not know what climate change is, but he is aware that the surrounding is different… I've heard a lot of farmers saying it's hotter… Along the highway I used to see those streams yearlong with water… But now as dry season comes they are dry. That means somehow upstream they have cleared the land, and there's not much water to run into the stream again.

The sense of disorientation presents a practical as well as epistemic-ontological dilemma, as the transition between wet and dry seasons is the most sensitive period of the year for many decisions. Sugar and hydropower workers pointed out erratic curves in rainfall graphs over recent years, explaining how decisions based on reckoning using historical trends had led to losses when environmental conditions did not conform to climatological expectations. In the previous seasonal cycle, the rains had continued beyond their usual terminating point, causing upset at harvest time for sugar farmers and refiners as fields were waterlogged and cane diluted. Recalling 2012 as "a horrible year", hydropower planners explained that they had drawn down reservoir levels late in the dry season, expecting plenty of rain as normal in July. When this did not materialise, they had to turn to more expensive power sources. As Vaughn (2017) argues for climate change adaptation projects in Guyana, "unruly" worlds can push experts to reconfigure their knowledge-seeking behaviours.

Reckoning otherwise

With the past thus destabilised as a reliable frame of reference, some decision-makers were seeking alternative foundations for foreknowledge. Hydropower managers and large-scale farmers were researching the use of dynamic forecasting models at daily to monthly timescales, and/or 'real-time' information from Met Service radar or private weather stations; smaller-scale farmers spoke of using near-term, situated indicators of rainy season onset such as animal behaviours: a more intimate form of reckoning in terms of both sensory and temporal proximity. Some eschewed the pursuit of more reliable information in favour of possibilities to reduce sensitivity to variability, for example through index-based crop insurance, soil and water conservation, crop diversification, and/or moral economies of collective support. In agriculture — as in other sectors — sensitivities to atmospheric conditions and to information vary, across crops, locations, scales and styles (e.g. mechanised or manual, irrigated or rainfed), and the social relationships in which they are embedded. Predicting future water resources is but one consideration: the question of what can be done about variable conditions is entangled with the capacity and values of the individual or organisation (electricity distributors worried about value for money; dam operators worried about infrastructure failure; water supply managers prioritised quality). A high-profile industrial dispute in the sugar sector during my stay demonstrated that while the timing of rains is important for the sugar harvest, political contingencies and negotiations of quotas, prices, and farmer autonomy are crucial (Haines, 2019). Anticipation as an affective state (Adams et al., 2009; Zaloom, 2009) may be experienced and addressed very differently according to how individuals and collectives are positioned and oriented in relation to environmental conditions, more-or-less shared systems of reckoning, decision-making processes, emotional engagements, and capacities to act on information.

This section has documented narratives of disorientation and anticipation that characterise efforts to reckon future water in the face of unruly points of reference. Weather and water resources emerged in these narratives less as external objects to be known and potentially managed, more as ontologically unstable — and potentially unknowable — atmospheres and waterscapes in which people and decisions are embedded. Reckoning future water involves relating points of orientation and reference: the work of communicating meanings often involves placing sensory experience in relation with shared cultural understandings, privileged units of measurement and narrated memories in the process of reckoning with environments as well as with politics and technology.

Discussion: Political lives of anticipation

In the first vignette, I described how water policy officials and scientists reckon with(out) data as they confront the political contexts of managing nonknowledge. The theoretical calculability and governability of future water quantity and quality are conjured by narratives that emphasise epistemic uncertainty (incomplete knowledge as a result of insufficient data), and express an urge to quantify, objectify and manage water via bureaucratic instruments such as assessments, masterplans and licenses. At the same time, many practitioners acknowledge that figuring current water, let alone anticipating what climate change/variability might do to it is a political problem, unlikely to be resolved by scientific data alone. The second account — of reckoning with models — drew attention to frictions underpinning ostensibly calculative modes of anticipation. Trainee modellers queried and translated the inputs to a model, producing multiple simulated visions of the extended future (via representations of quantitative calculations solved in each grid square). The experimental adjustments of inputs catalysed discussions about assumptions, expectations and entanglements of world, model and modeller; and about the relative portability of information conveyed by scientific calculations, observations from different locations, and personal experience. The significance of experience extends into the third vignette, which addressed the affective reckoning of people trying to orient their experiences, narratives and decisions within an atmospheric context perceived to be unstable. This further exceeds the 'formal' definition of reckoning as counting or calculation, raising questions about dealing with the ontological uncertainty of chaotic atmospheric systems and the reflexive uncertainty of human responses to information that may in turn influence atmospheric outcomes (Dessai and Hulme, 2004). As such, it draws attention to the definition of reckoning as challenge, opinion and judgment, and to the work involved in situating oneself in orientation to points of reference that are more or less socially salient.

These different modes of reckoning are not separate; indeed, affective dimensions resonated through all the situations described above — from the emotional frustrations of scientists feeling their work to be constrained, to policy workers' attempts to control unknowns of water and human behaviour, to the modellers' reflexive concerns about manipulability and urgency (and their instructions to 'dig' into the model landscape), as well as the disconcerting temperatures and colours sensed in environmental surroundings. Socio-material data and computational frictions (Edwards, 2010) also draw attention to frictions between worldviews (Tsing, 2005) that emerge in processes of reckoning uncertain futures and conveying their meaning, and which can cause discomfort, anxiety, disorientation, confidence, and excitement (Adams et al., 2009; Zaloom, 2009) as they draw participants into reflexive relation with technologies, environments, people and organisations.

Notwithstanding recognition of the difficulties of knowing current and future water, I encountered many people strongly invested in the promise of assessments, maps, and models for resource management, notably among a cross-sector community of GIS workers and enthusiasts who were active in workshops and on social media, sharing maps and promoting their benefits not only for water management but also for agriculture, forestry, health and journalism. The aspiration to scientific management draws attention to how relationships between the real and the virtual are imagined and managed, for what purpose. While policy ideals promote an integrated vision of watersheds as social as well as ecological systems, the focus on addressing these through data-led interventions risks overlooking the diversity and friction of political struggles and interpretive meanings of the future, and valorising frameworks that fund and legitimise only particular projects and principles — for example the principle of water as an economic good (Orlove and Caton, 2010).

Although some forecasters and scientists expressed interest in the knowledge that small-scale farmers could contribute to water management planning, others engaged in more defensive discourses, positing a hierarchical distinction between science and the knowledge of groups often described as less-educated farmers who 'plant by the moon'.[11] A few participants cited concerns about the predominance of inputs, instruments and infrastructures originating elsewhere in the world: models are often calibrated for particular locations; external donations and tools produced in distant 'centres of calculation' (Latour, 1987) bear the weight of historical relations and legacies of coloniality (Escobar, 2004; Quijano, 2007). As such, the world as political and contingent impinges on the view of the 'globe', even as the latter pretends to detachment: "each view contains the seeds of the other" (Ingold, 1993: 41). Real and perceived power imbalances within and between sectors or between governments and publics complicate efforts to map and manage: for example, attempts by sugar industry researchers to collect data on multiple variables for growers' fields were not universally welcomed by farmers (Haines, 2019); projects to demarcate land use in southern Belize have encountered and created complex political-ontological struggles

(Wainwright, 2008). Nonknowledge is threaded throughout these narratives — sometimes as potentially reducible epistemic uncertainty, but also as ontological indeterminacy and political critique (Mathews, 2014). It may be wielded as a resource by those in positions of authority; it can also create possibilities for considering multiple water futures and re-embedding water, weather and climate knowledge into social and political lives (Hulme, 2009).

Conclusion

In their discussion of reckoning, Kockelman and Bernstein (2012: 336-337) argue that creating knowledge claims that are portable across cultural and historical contexts often involves "long chains of responsibility and right, truth and justification, evidence and inference, technologies and techniques, everydayness and expertise, as well as modes of theoretical and practical agency". Latour (1999: 58), commenting on the durability of 'things', argues that it is through a "regulated series of transformations, transmutations and translations" that acts of reference work to ensure and maintain coherence of meaning. In this article, I have shown how different technologies, senses and expertise are put to work to compare past, present and future; to map and imagine different possible futures; and to influence (or hinder) policies and actions that may usher these futures into existence. I have drawn attention to the roles of *nonknowledge* and *friction*, and the socio-material dimensions of multiple modes of anticipation that craft water resources as temporal, relational, political and also *affective* phenomena, known and debated through 'abduction' (Adams et al., 2009: 255) — an orientation to the future that lies between 'is' and 'ought'; a condition of striving to know what to do under pressures of time.

Contested values and knowledge-making practices trouble the 'integration' promoted in contemporary global frameworks for water management. This is particularly salient when resources are contentious: water may be abundant in Belize now, but its deep connection with land, in a context where land is closely aligned with power, increase its potency as an object of politicised reckoning. Technical limitations, divergent values, intractable politics, and unstable environments are challenges for the relational work of reckoning, which is social and cultural given that its ability to convey meaning relies on shared understandings. These are of course crucial for wider publics as well as the professionals whose practices and perspectives have been the focus of this article: future extensions of this work could engage with reckoning practices of wider groups, and investigate change over time as water assessments and management interventions are enacted and socio-ecological settings continue to shift. As Nelson (2009) notes in her work on the aftermath of war in Guatemala, the notion of reckoning holds the promise of accountability, but also the power to unsettle objectivity as people and institutions struggle to produce 'facts', or — in the terms explored above — meanings that make sense across contexts. The modes of reckoning described here are anticipatory practices with political effects that stem from their capacity to orient themselves in the present while rendering certain visions of the future more or less imaginable (Taddei, 2013). Thinking in the multivalent terms of reckoning, then, draws attention to the inseparability of facts, values, and consequences in attempts to navigate human-environmental relationships in past, present and future. The notion of 'reckoning resources' points both to the socio-material *practices of reckoning* future water resources using different technologies, senses, inputs, standards and understandings, and also to the ways that these *tools for reckoning* are themselves resources that may be mobilised to bring (un)certain futures into view and possibly into being. As such, these reckoning resources hold potential as catalysts and vectors for political imagination.

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Notes

1 Participants have been anonymised.

2 Nelson (2009) also notes reckoning's multiple meanings, using the term to think through the difficulties of making sense of loss and accountability in the aftermath of war in Guatemala.

3 They derive their use of the term from Peirce (1929).

4 Kockelman and Bernstein (2012) suggest e.g. velocity, price, temperature and information.

5 According to the technical review, trends already recorded include: rising frequency of warm days and nights (with night-time temperatures contributing more to the overall increase in average temperatures — approximately 1 degree in the previous 39-45 years); and changes of variation in precipitation regimes (BEST, 2009).

6 Mandates have been reorganised since 2014; at the time of writing the Unit is in the Ministry of Natural Resources.

7 The Hydrology Unit relies heavily on local volunteer observers to collect river level data (of twenty-nine stations being monitored in 2014, three were automatic).

8 This number of rainy days has been used in applications of the N-SPECT model across the Mesoamerican Reef region, based on calibration by scientists working in partnership with the World Resources Institute (Burke and Sugg, 2006).

9 In contrast, Trinidad and Tobago's Met Office has declared the start of the rainy season based on assessments of rainfall events and tropical wave development. For example, in 2016 the rainy season (usually expected to start in June) was declared on May 2nd following an "uncharacteristically early influence from the Inter-Tropical Convergence Zone" on May 1st (Government of the Republic of Trinidad and Tobago, 2016).

10 See Jennings and Magrath (2009) for a report on farmers' perceptions of changing seasons across the world, and Macours et al. (2012) for an example from Nicaragua supported by longitudinal meteorological data.

11 Shorthand for planning agricultural activities according to the lunar cycle.